

# **Greening the U.S. House of Representatives**

*Rick Diamond and Christopher Payne, Lawrence Berkeley National Laboratory  
Grant Scherling, Office of the Chief Administrative Officer,  
U.S. House of Representatives*

## **ABSTRACT**

The Greening the Capitol initiative was launched in March, 2007 with the threefold goals of making the U.S. House of Representatives: 1) carbon neutral within 18 months, 2) reducing energy use by 50% in ten years, and 3) becoming a model of sustainable operations. We report on the recommendations to meet these goals, looking at the targets of opportunity at the Capitol Power Plant, the existing buildings, and the overall operations of the complex. Our findings have shown that these goals are achievable, and that through an integrated approach the savings in carbon and energy can be met. Specific examples include the lighting retrofits in the House offices, parking areas, and the Capitol dome; the retrofits to the HVAC systems and controls, including duct sealing, improving the efficiency of the energy and water use in the food service areas; and improved operations of the steam and chilled water distribution system. A key aspect has been better tracking and feedback to the building operators of the actual energy consumption. We report on the technical opportunities presented by these historic and symbolic buildings in becoming models of sustainability.

## **Introduction**

On March 1, 2007, Speaker Nancy Pelosi and Majority Leader Steny Hoyer, of the U.S. House of Representatives, directed the Chief Administrative Officer of the House to develop recommendations “to provide an environmentally responsible and healthy working environment for the U.S. House of Representatives.” The result was the report “Green the Capitol Initiative,” (CAO 2007) which recommended that the House adopt three goals for future operations:

1. Operate the House in a carbon-neutral manner by the end of the 110<sup>th</sup> Congress, i.e., by January 2009.
2. Reduce the carbon footprint of the House by cutting energy consumption by 50% in 10 years
3. Make the House operations a model of sustainability.

To achieve these goals, the report provided a summary of implementation strategies. These strategies provide the roadmap to reducing the carbon footprint of the House, while operating the complex in an environmentally sustainable manner.

## The House Buildings

Figure 1 Shows an aerial view of the U.S. Capitol and the associated buildings. The three House office buildings (Cannon, Longworth, Rayburn) are to the right of the Capitol, and the Capitol Power Plant (CPP) is just visible to the upper right.

**Figure 1. Aerial view of the U.S. Capitol buildings.**



The House buildings represent a diverse mix of office and support spaces, and include historical buildings as well as the new Capitol Visitor Center, currently under construction. The House building complex consists of seven buildings in the Capitol complex, accounting for 6.1 million square feet, roughly 40% of the 15.4 million square feet of the total Capitol complex area (Table 1).

**Table 1. Characteristics of the House Buildings**

<b>Building Name</b>	<b>Year Built</b>	<b>2006 Floor Area</b> [square feet]
Cannon House Office Building	1908	888,536
Longworth House Office Building	1933	682,791
Rayburn House Office Building (inc. E & W Underground Garages)	1965	2,971,469
Ford House Office Building	1939	594,730
House Page Dorm	1940	44,986
U.S. Capitol*	1793	421,800
Capitol Visitors Center	(under construction)	580,000
<b>TOTAL</b>		<b>6,122,312</b>

\*Only one-half of the Capitol floor area is under House jurisdiction

## Energy Consumption for the House Buildings

Energy is supplied to the House buildings from several sources. Electricity is purchased from the local utility and provided directly to the buildings. The buildings are on a district steam and chilled water loop supplied by the CPP, located on site. The CPP does not produce electricity, but purchases electricity to operate the chillers. The boilers of the plant primarily use coal or natural gas to produce steam that is distributed to many of the buildings. Some of the buildings (for example, the Ford House Office Building) have other suppliers of heating and cooling energy.

Table 2 shows total energy consumption in House buildings. The table includes energy consumption, primarily electricity, metered at each House building, electricity used by the CPP to provide chilled water to House buildings, and fuel used by the CPP boilers to provide steam heat to House buildings.

**Table 2. 2006 House Buildings Energy Consumption**

<b>Building Name</b>	<b>Metered Electricity (MWh)</b>	<b>Electricity (Million Btu)</b>	<b>Total Fuel (Million Btu)</b>	<b>Total Energy (Million Btu)</b>
Cannon HOB	9,126	31,138		31,138
Longworth HOB	8,761	29,893		29,893
Rayburn HOB plus East & West Underground Garages	28,046	95,694		95,694
Ford HOB	11,745	40,074	22,992	63,066
House Page Dorm	393	1,342		1,342
U.S. Capitol	12,709	43,363		43,363
Capitol Visitors Center	431	1,472		1,472
Capitol Power Plant @ 31%	32,199	109,862	433,259	543,121
<b>TOTAL</b>	<b>103,411</b>	<b>352,838</b>	<b>456,251</b>	<b>809,089</b>

Source: Architect of the Capitol 2007

HOB = House Office Building

The CPP provides chilled water and steam throughout the Capitol complex, not just to House buildings. Because metered consumption of chilled water and steam is not available for each House building, we had to estimate of the percentage of total CPP output that was attributable to the House buildings. Based on floor area data for the buildings served by the CPP, we estimated that 31% of the CPP output is attributable to House buildings. We then applied the 31% factor to total CPP electricity and fuel consumption to calculate the chilled water and steam energy consumption to the House buildings. In 2006, the total annual energy use for the House buildings was an estimated 809,100 million Btu (MBtu) expressed as site energy (not source energy).

Table 3 shows trends in electricity consumption for the House buildings between 2003 and 2006. There has been a 2% increase in electricity consumption by 2006 from the FY03 baseline established by the Energy Policy Act of 2005, with an even greater increase in electricity use in the House buildings. The power consumption at the CPP has been decreasing over the same period, due to the replacement of the chillers with more efficient equipment.

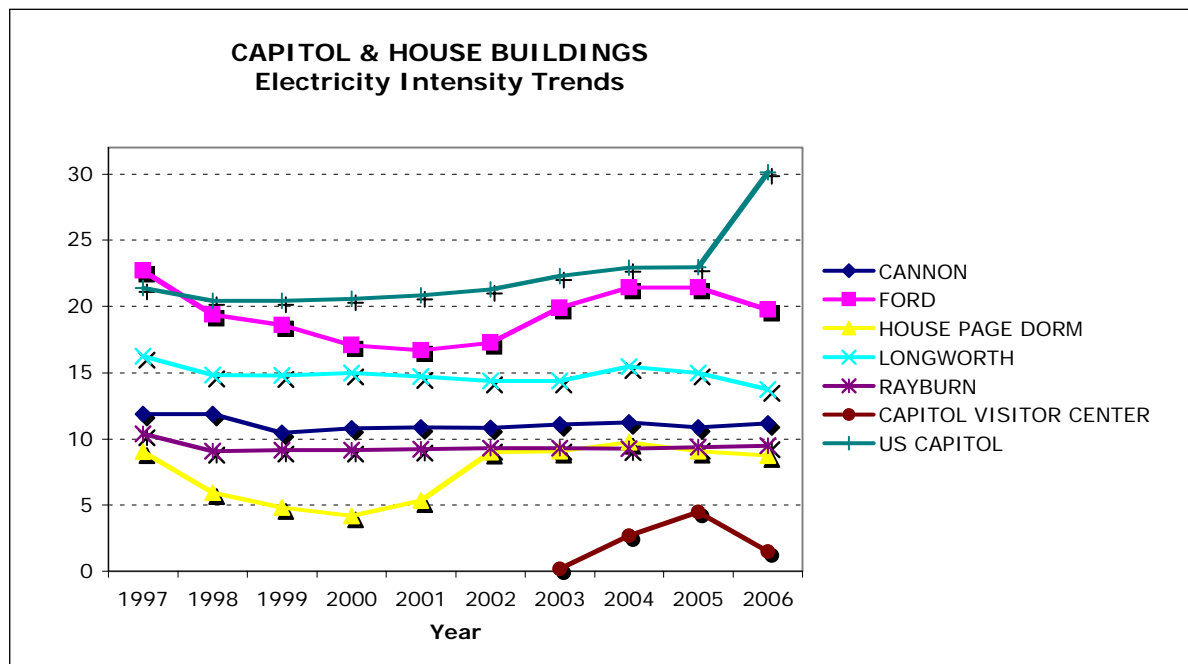
**Table 3. Trend in Electricity Consumption for House Buildings and CPP, 2003-2006**

House Buildings Electricity (MWh)					2006 Change from 2003 Baseline	
	FY 03	FY 04	FY 05	FY 06	MWh	%
Cannon HOB	9,057	9,205	8,890	9,126	69	1%
Longworth HOB	9,173	9,867	9,560	8,761	-412	-4%
Rayburn HOB	27,485	27,399	27,774	28,046	561	2%
Ford HOB	11,836	12,749	12,748	11,745	-91	-1%
House Page Dorm	410	439	409	393	-16,	-4%
U.S. Capitol (House only)	9,403	9,663	9,682	12,709	3,306	35%
House Total (kWh)	67,471	70,894	71,665	71,212	3,741	6%
Capitol Power Plant @ 31%	34,214			32,199	2,015	-6%
<b>TOTAL HOUSE &amp; CAPITOL POWER PLANT</b>	<b>101,685</b>			<b>103,411</b>	<b>1,726</b>	<b>2%</b>

Source: Architect of the Capitol 2007

Figure 2 shows the trends in electricity intensity (total electricity per floor area) for the House office buildings, and the wide variation between them.

**Figure 2. Electricity Intensity Trends for Capitol and House Buildings (kWh/ft<sup>2</sup>-yr).**



### Goal #1: Operate the House in a carbon-neutral manner by the end of the 110th Congress

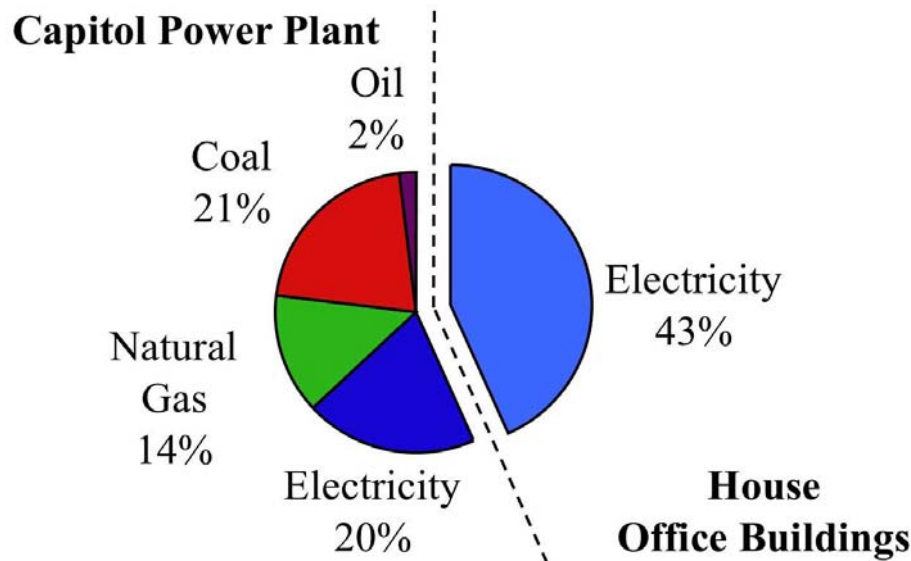
The report identified immediate steps that the House could take to provide leadership to address global warming. The House can make the operations of the House carbon-neutral, so that its net carbon dioxide equivalent (CO<sub>2</sub>-e) emissions become zero.

Using data developed by the Government Accountability Office, and reviewed by Lawrence Berkeley National Laboratory, the operation of the House complex was responsible for approximately 91,000 tons<sup>1</sup> of CO<sub>2</sub>-e emissions in fiscal year 2006. This value is equivalent to the annual CO<sub>2</sub>-e emissions of 17,200 cars.<sup>2</sup> Figure 3 shows the sources for the CO<sub>2</sub>-e emissions for the House buildings by fuel type. Electricity is purchased from the local utility and provided directly to the buildings. Heating and cooling for the buildings is provided by the Capitol Power Plant (CPP), located on site.

<sup>1</sup> Tons = English short tons (1 ton = 2000 pounds).

<sup>2</sup> Estimates were derived using coefficients for CO<sub>2</sub>-e emissions from the GAO April 2007 report and conversion factors for equivalent number of cars from the US EPA ([www.fueleconomy.gov](http://www.fueleconomy.gov)).

**Figure 3. Total 2006 Carbon Dioxide-Equivalent Emissions for House Buildings**



Three strategies were recommended to achieve carbon neutrality for the House buildings:

1. Purchase electricity generated from renewable sources
2. Switch from using coal, oil, and natural gas at the CPP to using natural gas only
3. Purchase offsets for the remaining carbon emissions

#### **Strategy #1: Purchase Renewable Power for Electricity Use**

Electricity use is the largest source of CO<sub>2</sub>-e emissions from House operations. To achieve the goal of making operations carbon-neutral, the Chief Administrative Officer (CAO) and the Architect of the Capitol (AOC) have negotiated with their energy service provider to purchase 100% of the electricity needs, approximately 103,000 megawatt-hours per year, from renewable sources beginning October 1, 2007. By implementing this recommendation the House will eliminate 57,000 tons of the total CO<sub>2</sub>-e emissions annually, or the equivalent of removing 11,000 cars from the roads.

#### **Strategy #2: Operate the CPP with Natural Gas**

The second strategy is to reduce the CO<sub>2</sub>-e emissions from the coal burned at the Capitol Power Plant (CPP) to meet the needs of the House of Representatives. The report recommended that the CPP use natural gas instead of coal and oil to meet the needs of the House. By taking this action, CO<sub>2</sub>-e emissions from the CPP will be lowered by 30% from the 2006 level, which is the equivalent of taking 1,900 cars off the road each year.

Because the boilers already have dual-fuel capabilities, they can be switched to natural gas and can use alternate fuel, either coal or oil, as emergency back-up.

### Strategy #3: Purchase Carbon Offsets on the Chicago Climate Exchange

Even by using electricity from renewable sources and switching the generation of steam to natural gas, the House will still need to offset 24,000 tons of carbon emissions to achieve the goal of carbon-neutral operations. The House has offset the remaining carbon emissions by purchasing, from the Chicago Climate Exchange, carbon credits specifically for projects in the United States. These offsets will be permanently retired so that the carbon credits cannot be used again. The CAO plans to purchase CO<sub>2</sub>-e offsets equal to House-attributable emissions on an annual basis.

### **Goal #2: Reduce the carbon footprint of the House by cutting energy consumption by 50% in 10 years**

While the House will achieve carbon neutrality by the end of the 110<sup>th</sup> Congress, the long term goal is to lower the carbon emissions, or the “carbon footprint,” by reducing energy consumption. Cost-effective investments in energy efficiency will pay for themselves and reduce the House’s annual operating costs. The report recommends a goal of reducing the House’s energy use by 50% over the next 10 years.

Energy management has been on the Capitol’s agenda for some years. While the potential for further gains is substantial, notable precedents exist in the House’s use of energy efficient technologies, and operational practices that enhance energy efficiency.

Several studies have recently been completed, or are currently under way, that characterize the energy use and carbon dioxide equivalent emissions (CO<sub>2</sub>-e) of the Capitol area complex. The Architect of the Capitol (AOC) is completing an assessment of the energy retrofits that can be undertaken as part of its overall facilities planning process. The Government Accountability Office (GAO) has issued a report documenting detailed analysis of the energy use and CO<sub>2</sub>-e emissions for the Capitol complex and outlined its “carbon footprint.” The House Science Committee is proposing demonstration offices to showcase energy-efficient and sustainable practices. Recommendations have been made by Carnegie Mellon University and others on specific measures that can be taken, both as short-term actions and through improved specifications for future retrofits. Various other energy audits and surveys have been conducted in the past, including energy efficiency and solar studies conducted by NREL in 2002.

Figure 4 estimates where energy was used during 2006 in the House office buildings, based on data from AOC and additional analyses. The largest use of energy in the House buildings is for cooling (38%), followed by heating (28%), lighting (17%), office equipment (7%), and miscellaneous other uses (10%), such as ventilation fans, elevators, and other equipment and appliances.

**Figure 4. Estimated Total Energy Use for Three House Buildings by End Use.**

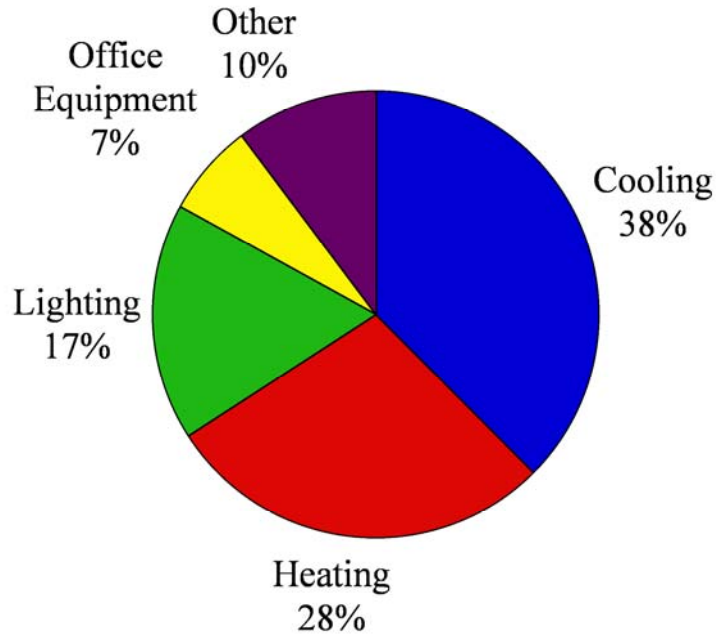
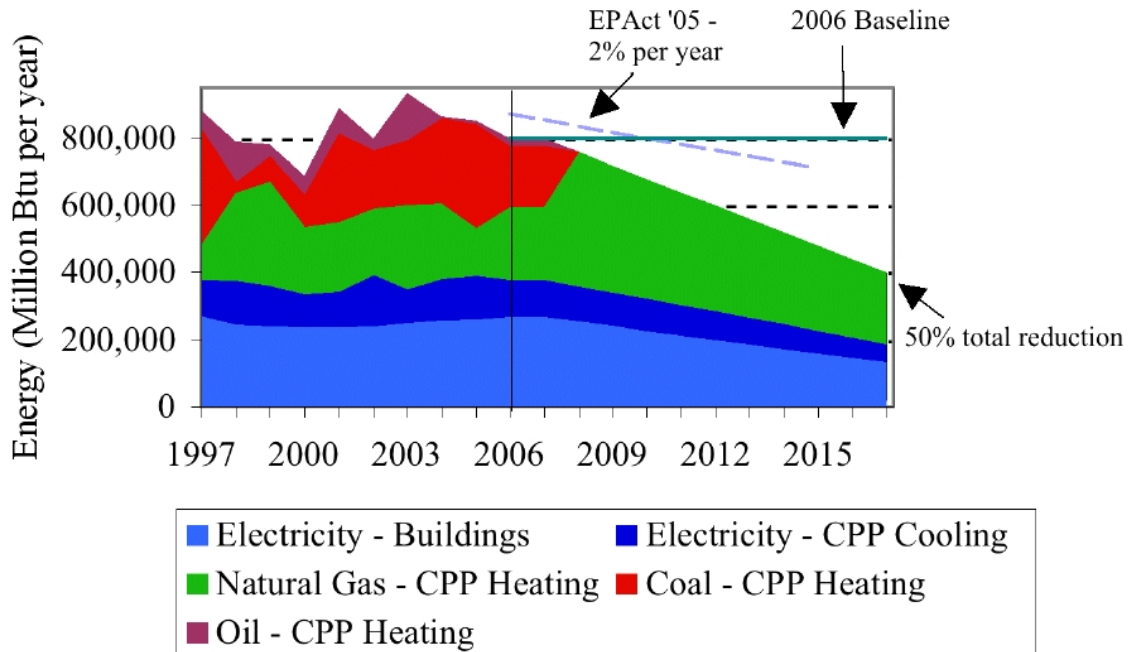


Figure 5 shows the proposed goal for cutting energy use by 50% by 2017. The reductions mandated under the 2005 Energy Policy Act are indicated by the dashed line. The proposed strategy more than doubles those savings.

**Figure 5. Energy reduction scenario for the House attributable consumption due to improved efficiency measures**





To achieve the 50% goal, the House will have to employ an optimal mix of life-cycle cost-effective investments in energy efficiency.

### **Recommendations for reducing energy use in the House Office buildings**

The report made several recommendations for reducing energy use in the House office buildings, including:

- Use metering, commissioning, and tracking to improve operating efficiency and management
- Install/upgrade steam meters for all House buildings
  - Install/upgrade chilled water meters for all House buildings
  - Optimize major steam and chilled water systems for energy efficiency during different seasons
  - Use utility tracking to monitor energy use during various times of day to identify energy savings opportunities
- Install energy efficient lighting
  - Retrofit ceiling lamps, fixtures, and controls to increase energy efficiency
  - Evaluate motion-activated lighting in offices, service corridors, tunnels, and parking areas to reduce energy use
  - Replace desk lamps (task lighting) with energy-efficient lamps
  - Conduct high-efficiency ceiling lighting pilot program
  - Evaluate exterior building lighting to reduce energy use
- Adopt new technologies and optimal operating practices for electronics and office equipment
  - Change computer operations to allow staff to centrally power-down equipment when unused for significant periods such as nights and weekends
  - Maximize power management efforts present in existing electronic equipment through periodic audits and employee education
  - Develop a preferred list of Energy Star-qualified and FEMP-designated office electronics
  - Devise strategies to consolidate equipment
- Update heating, ventilation, and air conditioning equipment and practices
  - Retrofit motors, fan drives, pumps, and valves with energy-efficient models.
  - Modify constant-air-volume equipment and controls so that air-handling systems operate as variable-air-volume systems
  - Seal air distribution ducts to minimize air leakage
  - Optimize fan schedules to avoid unnecessary equipment operation
- Make computer rooms and servers more energy efficient

- Improve operational control of data center auxiliary cooling and power systems
  - Consolidate servers distributed throughout House buildings into dedicated server rooms
  - Consolidate many lightly-used servers into fully-utilized server systems
  - Adjust air distribution in computer rooms for thermal optimization
- Evaluate food service practices, elevator and vending machine energy efficiency, hot water use, laundry and dry cleaning services, fitness center operations, and other House services for energy savings opportunities
  - Inventory current equipment and schedules to identify energy savings opportunities
  - Install new energy-efficient equipment and operating strategies.

The Capitol Power Plant is the largest single source of carbon emissions on the Capitol Hill. As noted earlier, switching to natural gas will reduce the CO<sub>2</sub>-e emissions of the CPP by 30%. The plant's operation has also been controversial because of visual and health concerns among Capitol Hill residents. The report recommended that the following actions should be taken to optimize operations of the CPP to maximize energy efficiency and to reduce energy consumption:

- Improve steam production efficiency
  - Evaluate reducing boiler steam pressure output from 200 PSI to 150 PSI
  - Implement best practices for operations and maintenance
  - Monitor energy efficiency performance
- Improve chilled water production efficiency
  - Implement best practices for operations and maintenance
  - Retrofit motors with premium efficient motors
  - Evaluate retrofit potential of variable-speed drives on pump motors
  - Monitor energy efficiency performance
  - Evaluate new efficient chillers for West Refrigeration Plant
- Improve steam and chilled water distribution systems
  - Improve maintenance of steam traps, increasing steam system distribution efficiency
  - Determine need for new insulation of all distribution lines to reduce heating and cooling losses
  - Adjust steam delivery pressures where practicable to follow heat load requirements in Capitol buildings

### **Goal #3: Make House operations a model of sustainability**

In addition to improving the way the House consumes energy, the report recommended that the House should provide an environmentally sustainable and healthy

working environment for employees. The House has the opportunity to lead by example by making its business operations a model of sustainability. In order to achieve this goal, every attempt will be made to purchase locally made, environmentally sustainable products.

### **Strategy #1: Direct the CAO to Oversee Implementation of the “Green the Capitol Initiative”**

The Office of the CAO was charged with the responsibility to oversee implementation of the “Green the Capitol Initiative” for the House of Representatives. This includes working with the AOC and other offices to improve the sustainability of the day-to-day operations of the House office buildings, including maintenance, finance, transportation, childcare, and food service.

### **Strategy #2: Develop a House Sustainability Plan**

In June 2007, the CAO convened a meeting with three sustainability leaders from major universities that are championing sustainability. Representatives from Harvard, Yale, and the University of California provided briefings on their goals, operations, and successes. A key component of their success has been a sustainability plan that provides focus and direction to reform efforts. The report recommended that the CAO develop and implement a House Sustainability Plan as a dynamic document, intended to provide a roadmap for major steps toward sustainability over the next 20 years and to identify timetables for specific actions.

### **Strategy #3: Leadership, Education, and Outreach**

The report recommended that the CAO should pursue networking and outreach with the Senate, other federal, state, and local governments, universities, businesses, and others to remain current on sustainability practices and CO<sub>2</sub>-e emission reduction opportunities. The networking would showcase the House’s leadership role and facilitate the exchange of ideas and information on environmentally sustainable issues. This activity would include hosting green summits on sustainability.

Recommendations for specific actions include:

- Prepare a checklist for sustainable office operations for use by Members of Congress and other Capitol Hill offices
- The House would take a leadership role in networking with the Senate, universities, businesses, and local and state governments including hosting green summits
- Hold a green expo for House offices to demonstrate the latest in green products or services available from commercial vendors
- Work with the AOC to make sustainability a mission-critical element
- Provide energy efficiency and sustainability materials for Capitol Hill visitors

### **Strategy #4: Develop Mechanisms for Evaluating Success and Reporting Progress**

The report recommended that the CAO should track benchmarks for energy consumption and CO<sub>2</sub>-e emissions monthly and prepare annual reports documenting

progress on the complementary goals of carbon neutrality and sustainable operations. Energy and CO<sub>2</sub>-e emissions data will be made available on a website, both as an educational tool and to provide feedback to House staff.

## **Conclusion and Future Work**

The Greening the Capitol Initiative provides a roadmap for carbon neutrality, energy efficiency, and operation of the House office buildings in an environmentally sustainable fashion. Based on these recommendations, the House has initiated a series of steps toward operating in a carbon neutral manner, and is on track to be carbon neutral by January 2009. The House has begun to implement the energy efficiency measures recommended to reach the goal of cutting the House's energy use by 50% in 10 years. Progress is being made on lighting efficiency, monitoring and metering, fuel conversion, duct sealing, variable speed drives, dome lighting, and several other areas. The House is also committed to doing business in an environmentally sustainable manner, and has undertaken a complete overhaul of its food, recycling, composting and waste management. A key requirement of this initiative is the reporting on progress towards these goals, and the House is implementing steps to have reports of its progress available to the public.

## **References**

Architect of the Capitol, July 2000. *Comprehensive Energy Conservation and Management Plan*. Washington DC.

Architect of the Capitol, March 2007. "2006 Annual Report, Energy and Water Management and Conservation." Washington DC.

Chief Administrative Officer, U.S. House of Representatives, June 21, 2007. *Final Report: Green the Capitol Initiative*  
<http://cao.house.gov/greencapitol/green-the-capitol-final-report.pdf>

Government Accountability Office, April 2007. "Energy audits are key to strategy for greenhouse gas emissions. GAO Report GAO-07-516. Washington DC.

## **Acknowledgments**

The authors would like to thank and acknowledge the contributions from the staff at Lawrence Berkeley National Laboratory, including Barbara Atkinson, Peter Biermayer, Steve Greenberg, Alan Meier, Evan Mills, Bruce Nordman, Francis Rubinstein, Steve Selkowitz, Tom Wenzel, Craig Wray, and Peng Xu. This work was funded by the Chief Administrative Officer of the U.S. House of Representatives, and the Federal Energy Management Program of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.